PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements in or relating to Structures and Units therefor

We, SOCIETE MEUSIENNE DE CONSTRUCTIONS MECANIQUES, a French Company, of Ancerville (Meuse), France, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement: —

This invention is concerned with structural units, a method of assembly of such units and with assemblies of such units in the form of structures, for example, piers, columns, beams, arches and vaults, which, for such possible reasons as weight or size require to be built up from separate members.

According to the invention, there is provided a structural unit comprising a group of at least four integral or interconnected elements surrounding and extending along an axis, the respective elements having, at least at one end of the unit, transverse terminations in a plurality of longitudinally spaced positions, the arrangement of said terminations being such that, when the elements are enumerated in serial order in an angular sense about said line and the serial positions of the enumerated elements are considered in the order in which said terminations occur from a point on said line, the sequence of said serial positions does not follow a progressively ascending or descending numerical order. An assembly of such units can be made by joining the units together in end-to-end relationship so that the end faces of their respective elements at said terminations form abutting registrations.

The term element is to be understood to include such forms as rods, bars, and tubes, whether straight or curved of any cross-sectional shape, e.g. circular, polygonal, convex or concave.

[*Pri*

Said serial position sequence, where there are an even number of $2n$ elements in the unit may run 1, $n+1$, 2, $n+2$, . . . n, $2n$. With six elements for example, the serially numbered elements would then have successive terminations occurring in the order 1, 4, 2, 5, 3, 6. Where there are an odd number of $2n+1$ elements in the unit, the sequence can run 1, $n+2$, 2, $n+3$ . . . . . n, $2n+1$, $n+1$ so that with seven elements, for example, the sequence is 1, 5, 2, 6, 3, 7, 4. It will be appreciated that such a non-progressive sequence is only possible when the number of elements is at least four. In the simplest case of four elements and two longitudinal terminal positions, alternate elements in said serial order will terminate at the same longitudinal position.

In a preferred feature of the invention, each element has, in the region of its termination, at least two adjacent face portions which extend angularly to each other to form a dihedron the apex of which is co-incident with the axis, the total angular extent of the dihedrons of the respective elements being equal to 360°. With this arrangement, assembly of successive units into a structure need only involve abutting registration of the end faces of these dihedrons and it is therefore possible to assemble together units having different modules, provided they are each composed of an equal number of elements, regardless of the other geometrical characteristics of the elements.

Where three or more longitudinal terminal positions are provided at an end of a unit according to the invention, it may be advantageous to arrange that the spacings of longitudinally successive pairs of terminations are equal.

In cases where the structures to be built up from the units are to have a generally

elongate form, such as masts, beams or arches, it may be convenient to give the elements of each unit an equal length. When this feature is present together with the features referred to in the preceding paragraph, it may be desirable to arrange that the spacing of the successive terminations is equal to the quotient of the common element length divided by the number of elements in the unit.

The invention will now be more particularly described with reference to the examples shown in the accompanying drawings wherein:

Figures 1_a and 1_b illustrate the formation of an assembly from two units according to the invention each constituted by a group of four prismatic elements;

Figure 2 is an end view of one of the tubular units of Figures 1_a and 1_b;

Figures 3 and 4 illustrate the elastic deformation which is available for the assembly of the two units shown in Figures 1_a and 1_b.

Figures 5_a and 5_b show a second example of the formation of an assembly of two alternative units according to the invention;

Figure 6_a shows one of the units of Figures 5_a and 5_b diagrammatically arranged in developed form and Figure 6_b shows a similar diagram of a four-element unit in an alternative arrangement;

Figures 7_a and 7_b show, in end view and in perspective respectively, the application of the invention to a structural unit of four angle members.

Figure 8 shows an application of the invention to a unit composed of elements which are in the general form of a quadrant;

Figure 9 shows a unit according to the invention employing rectangular tubular elements;

Figures 10_a, 10_b and 10_c illustrate, in an end view and two side views respectively, an application of the invention employing elements the general form of which is triangular and which are grouped in a cluster of six;

Figures 11, 11_a and 11_b show an application of the invention in units composed of six circular tubes arranged about a seventh tube;

Figure 12 shows an example of an interconnecting element or stud which can be introduced between the corresponding tubes of two consecutive units of an assembly for various purposes;

Figure 13 and 14 illustrate an alternative form of interconnecting element located between a pair of units according to the invention;

Figure 15 exemplifies an arched structure comprising pre-formed units according to the present invention;

Figure 16 exemplifies the application of the invention to the construction of posts or pillars for supporting floors; and

Figure 17 shows an example of the application of the invention to the construction of a mast.

A first example of a telescopic structural assembly according to the invention is illustrated in Figures 1_a and 1_b. In Figure 1_a one structural unit is given the general reference numeral 30 and comprises four square-section tubes 31 to 34 adjoining one another at a common edge 15. Each of these tubes constitutes an element of the unit. The end faces 132 and 134 of the tubes 32 and 34 are in one and the same terminal plane which is perpendicular to the edge 15, and the end faces 131 and 133 of the tubes 31 and 33 are in another terminal plane which is set back relatively to the terminal plane of the tubes 32, 34. Seen end-on, the tubes have the appearance shown in Figure 2. The tubes of the unit 30 are held together by means of spot welds such as 116, but this could also be achieved by any other known means such as collars, straps or bolts.

Arranged opposite the unit 30 in Figure 1_a is a second unit which is given the general reference numeral 40 and which is constituted by four square-section tubes 41 to 44 the arrangement of the end faces of which is complementary to that of the unit 30; that is to say, the end faces 142 and 144 of the tubes 42 and 44 (located opposite the tubes 32 and 33 of the unit 30) are set back relatively to the end faces 141 and 143 of the tubes 41 and 43 (located opposite the tubes 31 and 33 of the unit 30). The staggering of the terminal planes is identical in the units 30 and 40.

When the units 30 and 40 are brought towards one another the projecting end portions of their tubular elements slide over one another until the end faces 131 to 134 on the one hand and 141 to 144 on the other hand come into contact respectively. As will be apparent, the arrangement shown in Figure 1_b is then obtained.

At the instant when, in bringing the two units together along one and the same virtual axis, the end faces 132 and 134 arrive at the plane of the end faces 141 and 143, it is possible that, in order to pass beyond this position and initiate the sliding of the elements on each other, the same difficulties may be found as occur in conventional assembly work—this concerns the question of "fits" and may be illustrated by the example of a cylindrical tube that is to be slid onto a cylindrical bar the respective bore and diameter of which are nominally equal but in fact provide a small clearance of such size that once the tube is on the bar it is possible to slide it along the bar under the action of a continuous

relatively light pressure such as could be developed by hand (it will be recognised that such a fit is classed as a "sliding fit").

An assembly operation when such a fit is present involves two stages, even where the bar is securely fixed (for example in a vice) and where the weight of the tube is negligible in relation to the physical force required for the assembly manipulation.

In a first stage, the operator brings the tube to the end of the bar, locating it as co-axially as possible, and then he pushes it until it is completely seated on to the said end. But in order to do this, the operator must first overcome a difficulty for as he cannot orientate the axis (invisible since it is a virtual axis) of the tube exactly as it should be, he pushes without being able to avoid a certain "skewing" of the tube which is sufficient to cause jamming of the tube on the end of the bar; now, in order to eliminate this condition the operator will vibrate or rock the wedged tube, for example by giving it repeated small blows from a hammer. In this way time is taken and in any case a tool is required.

In a second stage of the assembly operation, the operator slides the tube from its position of introduction to the final position desired on the assembly which is being formed; to do this, he has only to overcome a certain resistance to sliding which is minimal relative to the resistance presented by the de-wedging forces applied in the first stage; when it is a question of a sliding fit he may achieve his result by hand pressure.

It will be seen that any difficulty involved in fitting a tube on a bar in this way is concentrated in the first stage, that is to say the beginning of the assembly operation. It is true that the provision of chamfers on the ends of the tube and the bar is capable of reducing the difficulty to some extent but removing it totally would involve temporarily increasing the bore of the tube relatively to the diameter of the bar to such an extent that the original small clearance is transformed into a relatively large gap. In any case, such temporary dimensional changes require expensive and intricate tool equipment and processes (for example, expansion by heating or cold elastic expansion).

On the other hand, to assemble two units according to the invention, such as 30 and 40 in Figures 1_a and 1_b, it is possible to create an ample space between the end faces 141 and 143, for example, by using the flexibility of the tubes 41 and 43 and urging them transversely from one another by hand or using a tool such as a punch or a screwdriver as a wedge. This spacing is shown at 100 in Figure 3 and it is clear that it will then be easy to slide the ends of the tubes 32, 34 past the plane of the end faces 141 and 143 in the respective positions shown in Figure 4.

The movement of the faces 132, 134 past the plane of the faces 141, 143 corresponds to the first stage of the fitting of a cylindrical tube on a cylindrical bar, as described hereinbefore, but with a unit according to the present invention this first stage may be effected more easily. The temporarily formed opening is then allowed to close by removing the transverse force that has been applied to the tubes 41, 43. The second stage of the assembly, namely sliding of the units on each other until the final assembly position is reached, presents no more difficulty than in the case of a cylindrical tube and bar.

In Figures 3 and 4, the spacing has been exaggerated in order to illustrate the effect of the flexibility more clearly. This flexibility after being used for the assembly may be neutralised by spot welds between pairs of tubes belonging to the two different units when these tubes have been brought adjacent one another by the assembly of the units. Such spot welds may be similar to those shown at 116 (Figures 1_a and 1_b) between two tubes of the same unit. The units are then permanently assembled.

If it is not desired to have a permanent assembly welding is not carried out between the units. In order to neutralise the residual flexibility, it is possible in such cases to use studs or other interconnecting devices the use of which will be described hereinafter in connection with Figures 12, 13 and 14, since this use is not peculiar to the units described in connection with Figures 1 to 4.

It will be noted that only two side faces of each tube are involved in the sliding assembly of the units described, namely the faces 111 and 112 (Fig. 1_a) as far as the tube 41 is concerned for instance. The other side faces of this tube increase the rigidity of the assembly but do not play any part in the assembling operation. The two active faces of each tube form a dihedron whose apex line coincides with the common edge line 25 of the tube of the unit 40; this edge line thus constitutes in a sense the axis of the unit and the dihedrons are distributed uniformly about it. In other words, the unit has the characteristic that each element has, in the region of its terminal plane, at least two adjacent face portions which extend angularly to each other to form a dihedron the apex of which is co-incident with the axis, the total angular extent of the dihedrons of the respective elements being equal to 360°.

A second structural assembly in conformity with this preferred characteristic is illustrated in Figures 5_a and 5_b. In Figure

5_a a tubular unit which is given the general reference numeral 50 comprises four tubes 51 to 54, each of the same length L and having square cross-sections, with a common edge 115. The end faces 151 to 154 of these tubes are offset relatively to one another in the longitudinal sence by lengths which can for example be multiples of a quarter of the length L of each tube: thus, the end face 153 of the tube 53 is offset by $L/4$ from the end face 151 of the tube 51, the end face 154 of the tube 54 is offset by $L/4$ from the end face 153, and the end face 152 of the tube 52 is offset by $L/4$ from the end face 154.

Figure 5_a also shows opposite the unit 50 a unit 60 formed of tubes 61 to 64 the end faces of which have been given the references 161 to 164; this unit 60 is geometrically identical to the unit 50; the projecting end faces of one correspond to the recessed end faces of the other. It will easily be seen that by bringing the two units axially together and interlocking their tubular elements, the end faces 151 and 161, 153 and 163, 154 and 164, 152 and 162 (not visible) respectively are brought into contact with one another and the assembly shown in Figure 5_b is formed.

It will be apparent that the length of the tubes of a unit can be much greater relative to the width of the tubes than Figures 5_a and 5_b show. The proportions chosen for the drawings have the merit of making it possible to show complete units formed of tubes of clearly apparent cross-section; but these proportions will often be departed from in practice.

Figure 6_a shows a planar development of the unit 50 of Figures 5_a and 5_b (or the similar cluster 60) to illustrate the successive longitudinal staggerings of the tubes. Thus, if the terminations are considered in their axial order at the lower end of the assembly, their sequence is 151 to 153 to 154 to 152 so that the order of termination of the tubes can be taken as 51, 53, 54, 52 or, when enumerating the tubes in serial order about the axis of the assembly, 1, 3, 4, 2.

Referring once again to Figure 2 it will be seen that the order 1, 2, 3, 4 in one angular direction becomes the order 1, 4, 3, 2 in the other angular direction, the tube 132 taking the sequential position of the tube 134 and *vice versa*. The enumerated order 1, 3, 4, 2 of Figure 6_a is similarly modified to the order 1, 3, 2, 4 on the schematic illustration in Figure 6_b, which is also a suitable arrangement for use in the present invention, naturally on condition that the direction of numbering is the same for all the units which are to be fitted to one another.

Figure 7_a (in section or end view) and Figure 7_b (in perspective) show a unit comprising four angle members of equal length about a common edge line 215 the angle members being staggered in a similar manner to the elements of Figures 6_a or 6_b so as to be able to interlock with an identically constituted assembly in the manner already described. The width of the flanges of the angle members is immaterial however and may vary from one unit to another. These Figures 7_a and 7_b illustrate the essence of one feature of the invention already referred to in that the unit elements are reduced to dihedrons whose faces can slide on those of the consecutive unit of dihedrons, the complementary terminal faces being brought into contact when the assembly is completed.

Figure 8 shows an application of the invention to a unit of four tubes whose cross-section is a quadrant and which adjoin each other at their right-angled edges. Figure 9 illustrates a unit composed of rectangular-section tubes; it will be appreciated that these tubes may be flat enough to adopt a certain curvature without preforming in order to form a light vault frame which is easy to erect and dismantle.

Figure 10_a is an end view and Figure 10_b an elevational view of a unit having six tubular elements 101 to 106, the cross-section of each being in the form of an equilateral triangle with rounded corners and with a curved base, assembled together at their apex about an axis of symmetry 315 by welds such as 316. In one direction along the axis 315, there occur in succession end faces 201 of the tube 101, end face 204 of the tube 104 (not shown), end face 202 of the tube 102, end face 205 of the tube 105, end face 203 of the tube 103 (not visible) and end face 206 of the tube 106. The axial spacings are the same and the peripheral sequence of their occurence is 201, 204, 202, 205, 203, 206 (i.e. 1, 4, 2, 5, 3, 6).

In Figure 10. there has been shown a unit complementing the unit of Figure 10_b; the ends of the two units can be slid upon one another and the homologous end faces of the two units which have reference numbers differing by 10, such as 201 and 211, are then in contact.

In Figures 10_b and 10_c there have been shown units constituted of tubes of a relatively large module which fit telescopically on one aother over a relatively short length. The proportions of these Figures make it possible to appreciate the inter-relationships of the assembly, but they do not correspond to certain practical cases where it is advantageous to distribute the terminal planes of the unit elements over a greater length of the axis of symmetry 315 which constitutes the neutral axis of the units. Such increase in the spacings of

said planes can facilitate assembly since the flexibility of the projecting element ends is thus greater and can be utilised to greater advantage for the successive passing of terminal planes when the assembly is actually being formed. Futhermore, when assembly has been effected, a wide distribution of joints is a factor tending to make for greater rigidity.

It is for the sake of easier understanding of the drawings that in Figure 10_a the tubes 101 to 106 have been shown clearly separated; while the plane longitudinal faces of two adjacent tubes, for example 113 and 114, do not appear to be in contact, in fact they are; if there were a clearance comparable to that illustrated in the drawings, the assembly of two units might have less rigidity than that which can otherwise be obtained.

The examples of units according to the invention which have been described hitherto, namely those in Figures 1_a to 10_c inclusive, all satisfy one preferred feature of the invention in that two face portions of each element form a dihedron with an apex at the neutral axis, these portions playing a part in the assembly of successive units.

A description will now be given in connection with Figures 11, 11_a and 11_b of a further form of unit according to the invention constituted by elements which have no such face portions.

The cluster designated with the general reference numeral 220 in Figure 11 is constituted by six tubes 221 to 226 (the tube 224 is not visible) peripherally grouped about a central tube 227. All the tubes have the same diameter. The peripheral tubes form a hexagonal arrangement as will be apparent from Figure 11_a, which shows them diagrammatically in plan view.

The tubes with odd reference numbers 221, 223, 225 terminate in end faces 321, 323 and 325 which are in one and the same terminal plane. The end faces 322, 324 (not visible) and 326 of the tubes which have even reference numbers 222, 224 and 226 are in a terminal plane recessed relatively to the first-mentioned plane. In the diagrammatic representation in Figure 11_a, the tubes whose end faces are set back have been shown in broken lines. The central tube 227 extends slightly beyond the tubes having odd reference numbers and it terminates in tapered portion 327 which has the object of facilitating the assembly of the unit 220 with a complementary unit as will be explained hereinafter.

Such a complementary unit is illustrated at 230 and comprises tubes having even reference number 232, 234, 236, and tubes having odd reference numbers 231, 233 (not visible) and 235, which are set back relatively to the tubes with even-references. Figure 11_b is a diagrammatic representation in which the set-back tubes have been shown in broken lines.

If the units 220 and 230 are brought towards one another, keeping them substantially co-axial, the portion 327 of reduced diameter can easily be engaged between the end faces 332, 334 and 336 of the tubes 232, 234 and 236, and thus in the same operation the mouths of the two units are centered relative to each other. In this way movement of the end faces 321, 323 and 325 of the unit 220 past these end faces 332, 334 and 336 is facilitated. Once this passing movement has been effected, the remainder of the assembly operation is easily carried out.

In cases where the units to be assembled are to constitute a structural assembly capable of being subjected to a certain bending moment, and where the neutralisation of the flexibility used in assembly as described in connection with Figures 3 and 4 cannot be obtained by welding between two assembled units since, for example, the assembly is to be capable of being dismantled, the bending moment experienced may end to cause the joints at the end faces of two end-to-end elements to gape open. In such a case, it may be convenient, when assembling the units, to interpose between each of the pairs of homologous tubes an interconnecting device or stud such as that shown in Figure 12. The central portion 70 of this stud is, for example, cylindrical and terminates at annular shoulders 71 and 72 on which the end faces of tubular elements such as 75 and 76 (indicated by broken lines) bear after inter-fitting of two successive units. On each side of the central portion projections 73 and 74. These projections match the internal form of the tubes and which terminate in a point or in a portion of reduced diameter and a plane face, but capable of having any other form inscribed within the tubes (cylindrical in the case of a square tube for example), facilitate the positioning of the units end to end. The central portion 70 can match the external cross-sectional shape of the two tubes or can take some other form that lies within their external perimeters.

A form of interconnecting device or stud differing slightly from the foregoing example is shown in Figures 13 and 14 at 175, fitted between two square tubes 53 and 63. Adjacent tubes of the assembly are indicated by the reference numerals 61, 52 and 54, the reference numerals corresponding to those in Figure 5_a. Central portion 170 of the stud 175 is of square cross-section and matches the external contour of the tubes. No sharp protuberances result therefore from the presence of the studs when the assembly is completed, which is an advantage in certain cases, for example in cases

where a canvas is to be laid over the assembly.

Such studs can be positioned by hand without the use of any tools, owing to the slight conicity given to the inserted ends.

Interconnecting devices of this nature can also be used in cases where the assembly is intended to be permanent and is secured by welding, particularly in cases where the assembly is to have considerable rigidity before the welds in question are completed.

The interconnecting devices can also be used in the conditions illustrated in Figure 15, which show an application of the invention to the construction of parallel arches 81, 82 constituted by juxtaposed units each of four square-section tubes which have previously been curved, the devices having been interposed between the said units. Between the arches a strut 83 is fixed at its two ends to the devices 84 and 85 by any desired conventional process, for example, the devices can have been provided with an eye, a hook or a tapped hole. On another device 86, a similarly known attachment is used for the suspension of lighting apparatus, for example, or any other article of ancillary equipment.

Figure 16 shows an application of the invention to the construction of pillars or piers or struts supporting, for example, floors of a building. These pillars such as 87 are shown formed of juxtaposed units each of four square-section tubes. Plates 88 and 89 are fixed to the pillars by any suitable means. It will be seen that a simplification of the construction is afforded by making it possible to insert the plates on the units which are to support them before positioning the upper units. The invention may similarly be applied to the support of platforms.

Figure 17 shows an application of the invention to the construction of a mast constituted by units such as 91 of tubes of decreasing module in the direction from the bottom of the mast to the top. Stay-ropes such as 92 are fixed either to the tubes themselves or to interconnecting devices previously inserted between two adjoining units.

This last construction underlines an advantage of the method of assembly that can be employed using units according to the invention in that a minimum of equipment can be employed. In fact, in order to position the successive units, the hoisting apparatus required need be much less powerful than would be required to erect a one-piece mast having the same final characteristics.

In conventional structural assemblies, it is common for the assembly work to occupy two stages, in a first of which the parts are brought together and held by temporary means, and in the second of which such temporary means are replaced by permanent fastenings. As examples, in assemblies using rivets, bolts are placed temporarily in the rivet holes while in welded assemblies, retaining straps are first secured and are removed after the welding operation proper. The illustrations given hereinbefore of structure employing units according to the present invention indicate how, with these units, the initial locating operations prior to final securing can be simplified and shortened.

The units of the present invention are, of course, capable of modification in other ways than those given in the illustrated examples. Thus, while the terminations of the elements of the units particularly described have been shown lying in flat planes this is not a necessary feature, nor need these terminations extend in more than a generally transverse direction to the unit axis although the illustrations all show the particular case of terminations perpendicular to their unit axis.

WHAT WE CLAIM IS:—

1. A structural unit comprising a group of at least four integral or interconnected elements surrounding and extending along an axis, the respective elements having, at least at one end of the unit, transverse terminations in a plurality of longitudinally spaced positions, the arrangement of said terminations being such that, when the elements are enumerated in serial order in an angular sense about said line and the serial positions of the enumerated elements are considered in the order in which said terminations occur from a point on said line, the sequence of said serial positions does not follow a progressively ascending or descending numerical order.

2. A unit according to claim 1 having a group of $2n$ elements wherein said serial position sequence is 1, $n+1$, 2, $n+2$, . . . n, $2n$.

3. A unit according to claim 1 having a group of $2n+1$ elements wherein said serial position sequence is 1, $n+2$, $n+3$, . . . n, $2n+1$, $n+1$.

4. A unit according to any one of claims 1 to 3 wherein the elements are metal tubes.

5. A unit according to any one of the preceding claims wherein, at both ends of the unit, the elements have a corresponding serial position sequence of said terminations and there are corresponding distances between the longitudinally spaced positions of each end.

6. A unit according to claim 5 wherein the elements are of equal length.

7. A unit according to any one of the preceding claims having at least three ter-

minal positions at said or each end and wherein the spacings of longitudinally successive pairs of said positions are equal.

8. A unit according to Claim 6 together with Claim 7 wherein said spacing is equal to the quotient of said element length divided by the number of elements in the unit.

9. A unit according to any one of the preceding claims wherein each element has, in the region of its termination, at least two adjacent face portions which extend angularly to each other to form a dihedron the apex of which is co-incident with the unit axis, the total angular extent of the dihedrons of the respective elements being equal to 360°.

10. A unit according to any one of Claims 1 to 8 wherein said group of elements are arranged about a central element or core co-extending therewith.

11. A unit according to claim 10 wherein said central element or core extends beyond the axially outermost termination of said group at one end of the unit.

12. A structural assembly comprising a plurality of units according to any one of the preceding claims, joined together in end-to-end relationship so that the faces of their respective elements at said terminations form abutting registrations.

13. An assembly according to Claim 12 wherein the elements have hollow ends at said terminations, interconnecting devices being located between pairs of elements of successive units to seat in the hollow ends of said elements, the faces of said respective pairs of elements thereby being arranged to abut opposed faces of their associated device.

14. An assembly according to Claim 13 wherein said devices are provided with attachment means for the connection thereto of additional structural members and/or ancillary equipment.

15. An assembly according to any one of Claims 12 to 14 in the form of a strut or pier.

16. An assembly according to any one of Claims 12 to 14 in the form of a beam.

17. An assembly according to any one of Claims 12 to 14 in the form of an arch.

18. A method of structural assembly employing a plurality of elongate units, each unit being made up of a group of at least four elements surrounding and extending along an axis, said elements being axially related so as to terminate, at least at one end of the unit, at a plurality of longitudinally spaced positions, the arrangement of said terminations being controlled in order that, when the elements are enumerated in serial order in an angular sense about said line and the serial position of the enumerated elements are considered in the order in which said terminations occur from a point on said line, the sequence of said serial positions does not follow a progressively ascending or descending numerical order, said ends of two successive units of a structure being given complementary terminal configurations whereby they may be assembled to each other by sliding co-axially together, the faces of their respective elements in said longitudinal positions forming abutting registrations.

19. A method according to Claim 18 wherein the terminal portions of the axially outermost elements of at least one of two successive units, at least at one end thereof, are unconnected in the terminal regions extending from an inner termination of said one end, said unconnected portions being resiliently deformable away from the unit axis during the co-axial introduction of the axially outermost terminal portions of a succeeding unit.

20. A method according to Claim 18 or Claim 19 wherein the terminal portions of the units are hollow and interconnecting devices are slid into respective hollow ends of adjoining elements of a pair of units during the assembly of the units to each other.

21. A method according to Claim 20 wherein said interconnecting devices each have a pair of opposed shoulders against which the faces of a pair of elements having complementary terminal positions on their respective units are brought into abutment.

22. A structural unit constructed and arranged substantially as described herein with reference to Figs. 1_a, 1_b and 2 either alone or as modified by Figs. 3 and 4 and/or Figs. 6_a and 6_b and/or Figs. 7_a and 7_b and/or Figs. 8 or 9 or 10_a or 11.

23. A structural assembly constructed and arranged substantially as described herein with reference to Figs. 1_a, 1_b and 2 or Figs. 10_a, 10_b and 10_c or Figs. 11, 11_a and 11_b either alone or as modified by Figs. 3 and 4 and/or Figs. 5_a and 5_b and/or Fig. 12 or 13 or 14.

24. A structural assembly according to Claim 21 constructed and arranged substantially as described herein with reference to Fig. 15 or Fig. 16 or Fig. 17.

25. A method of structural assembly substantially as described herein with reference to the accompanying drawings.

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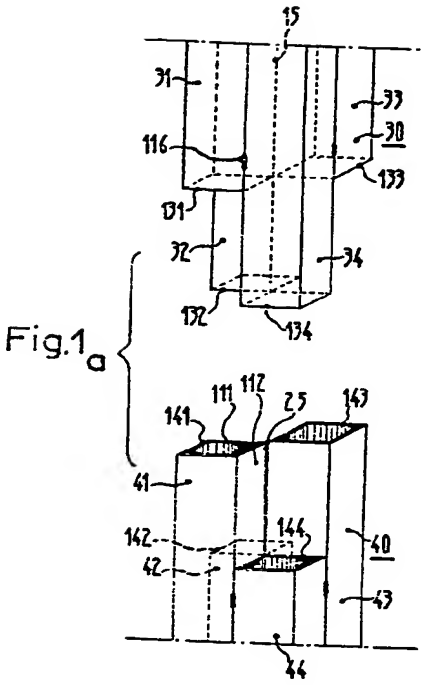


Fig.1a

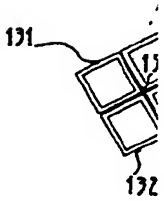


Fig.

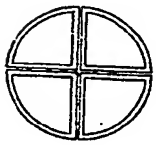


Fig.8

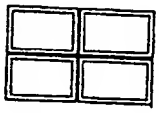


Fig. 9

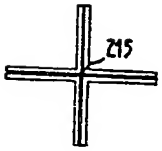


Fig. 7 a

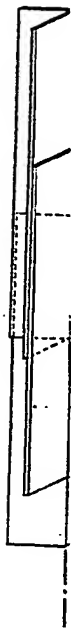
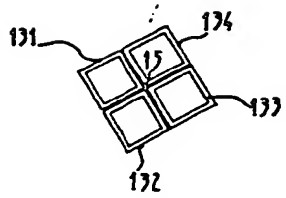


Fig. 7 b

1033890 COMPLETE SPECIFICATION
7 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

Fig. 2



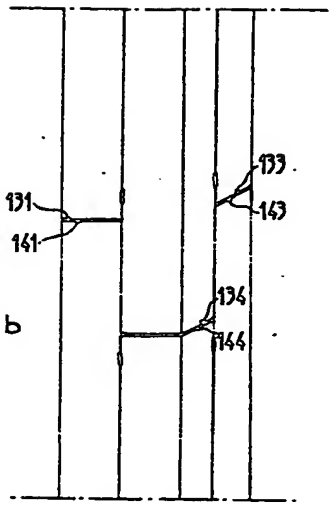


Fig. 1 b

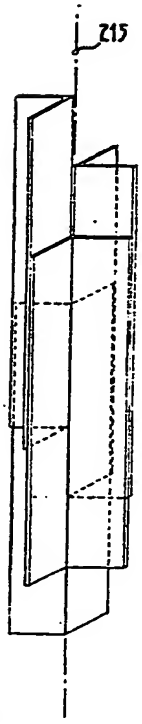


Fig. 7 b

Fig. 6 a

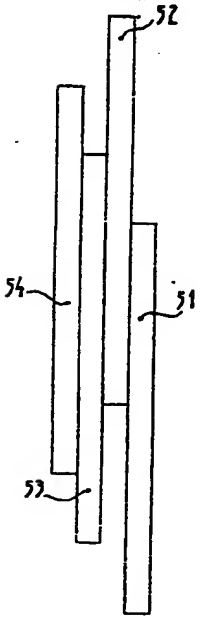
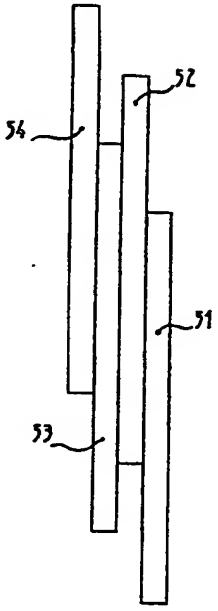


Fig. 6 b



1033890 COMPLETE SPECIFICATION
7 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
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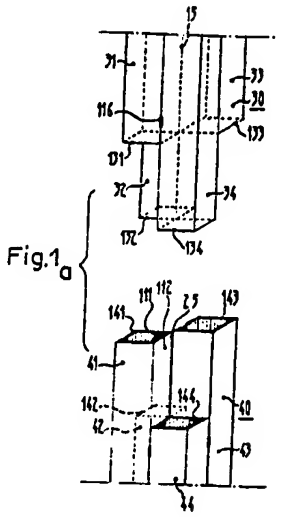


Fig.1a

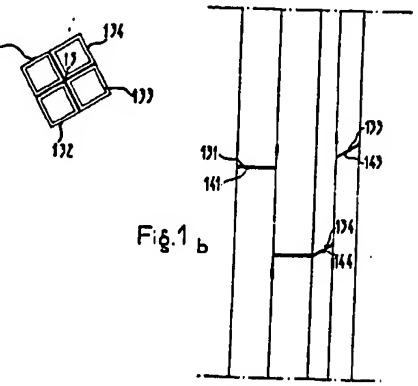


Fig.1b

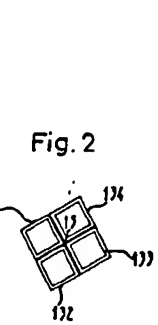


Fig. 2

Fig.8

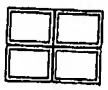


Fig.9

Fig. 7a

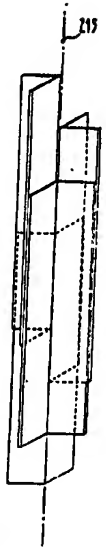


Fig. 7b

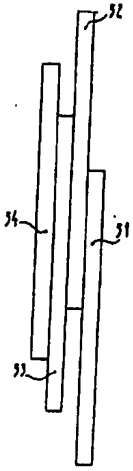


Fig.6a

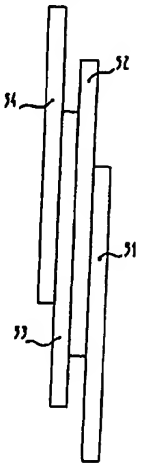


Fig.6b

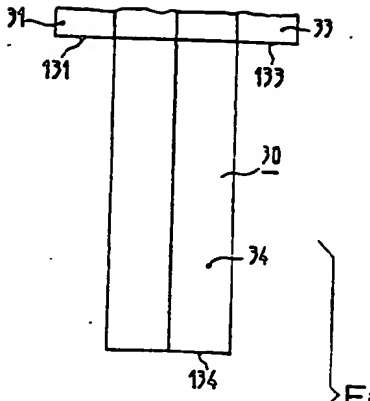


Fig.3

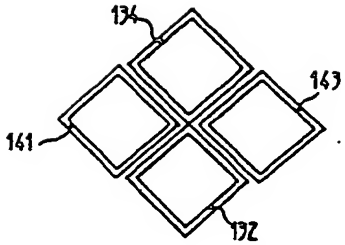


Fig.4

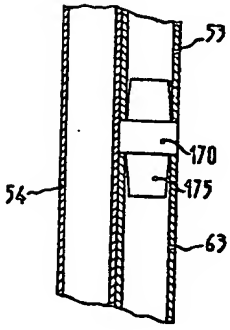


Fig.13

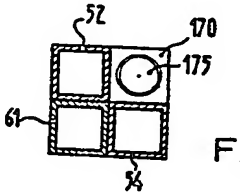
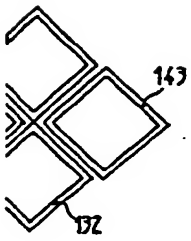
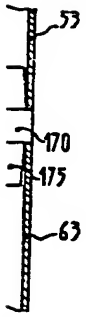


Fig.14

1033890 COMPLETE SPECIFICATION
7 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheets 2 & 3

Fig.4





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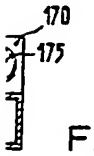

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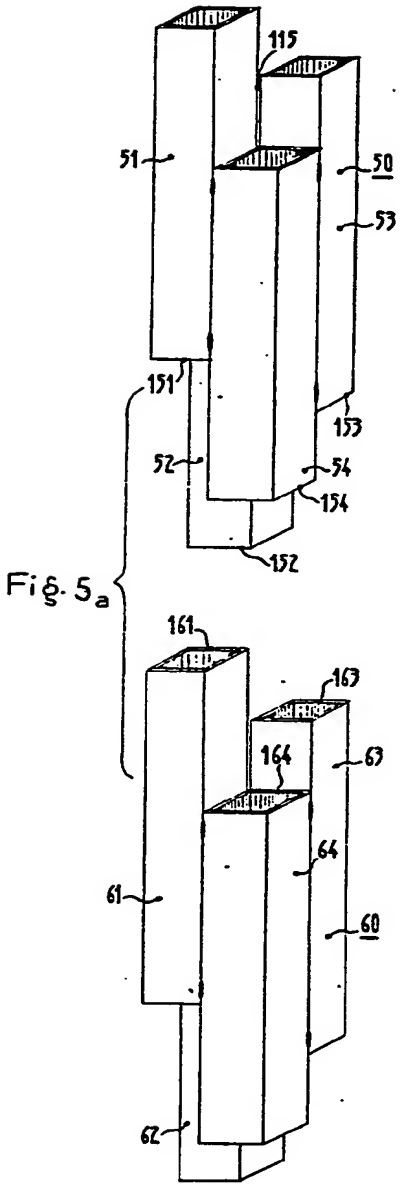


Fig. 5a

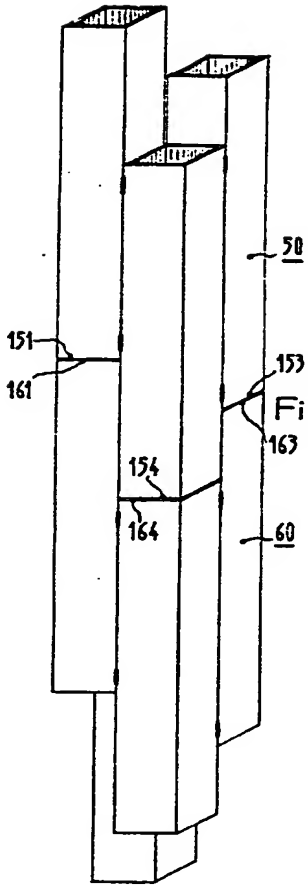


Fig. 5b

1033890 COMPLETE SPECIFICATION

7 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheets 2 & 3

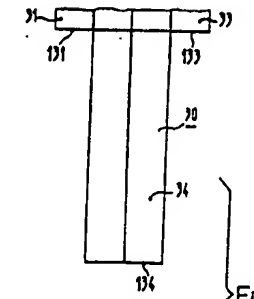


Fig.3

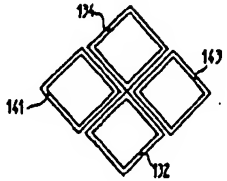
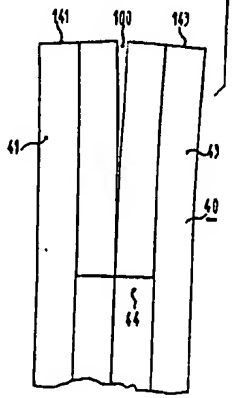


Fig.4



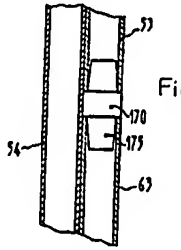


Fig.13

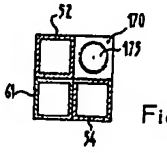


Fig.14

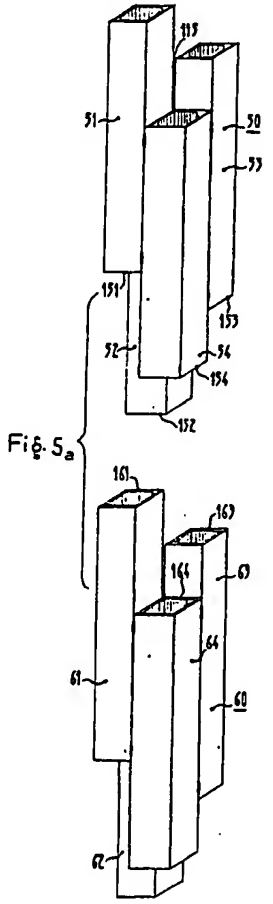


Fig. 5a

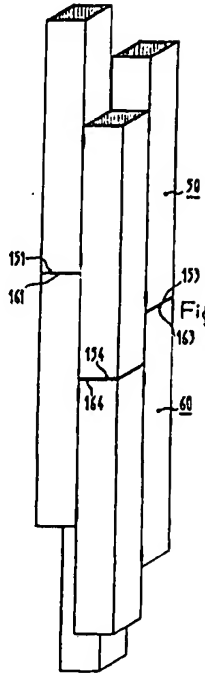


Fig. 5b

Fig.10b

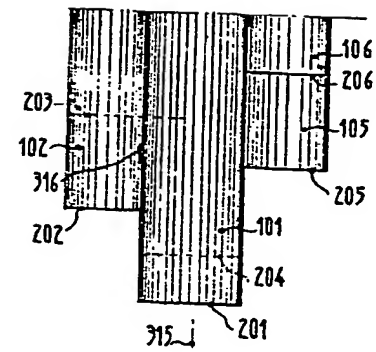


Fig.10c

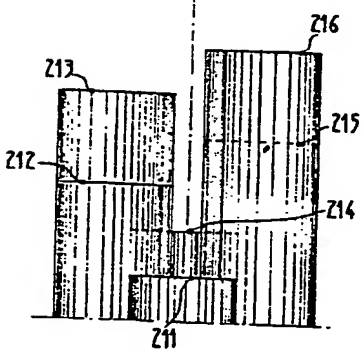
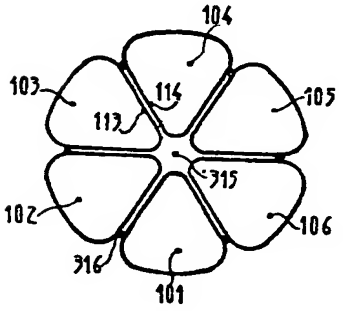
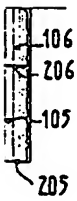
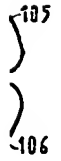


Fig.10a



1033890 COMPLETE SPECIFICATION
7 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheets 4 & 5





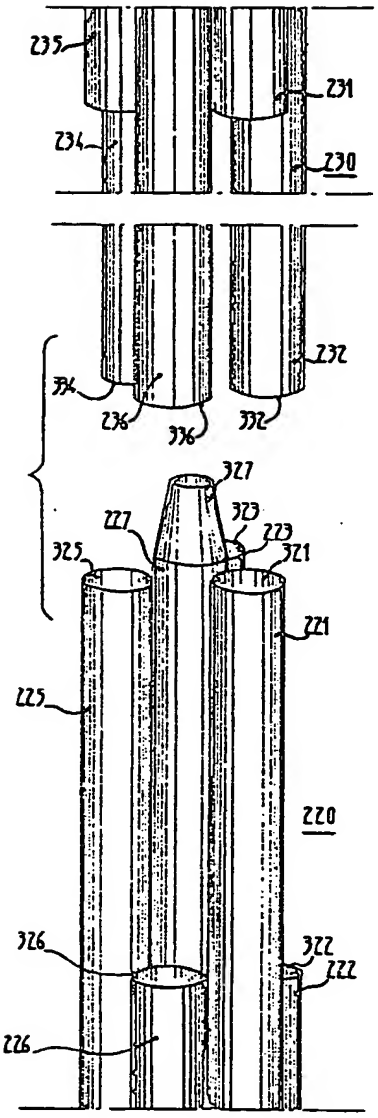


Fig. 11

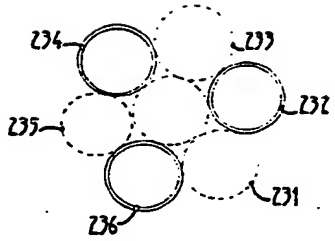


Fig. 11b

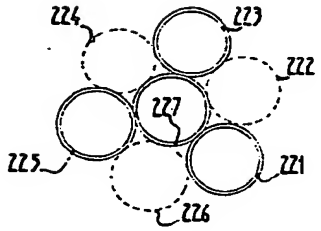


Fig. 11a

1033890 COMPLETE SPECIFICATION
7 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheets 4 & 5

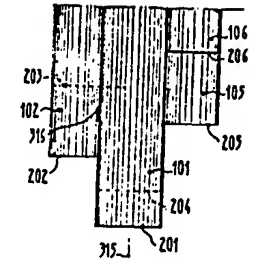


Fig.10b

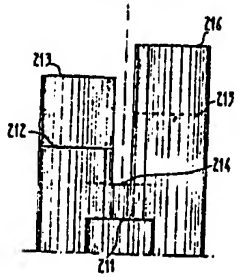


Fig.10c

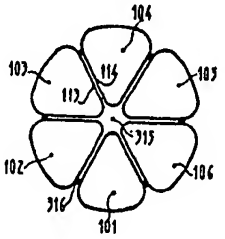


Fig.10a

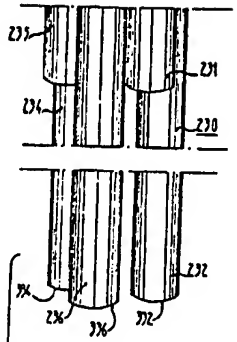


Fig. 11

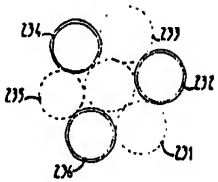
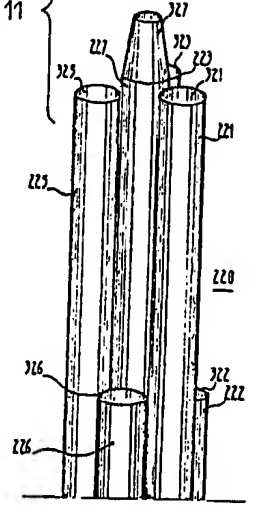


Fig. 11b



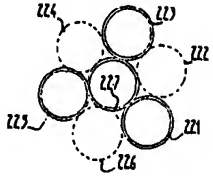


Fig. 11a

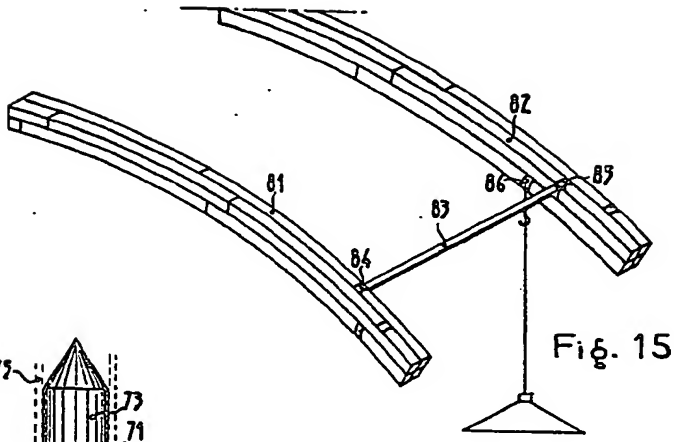


Fig. 15

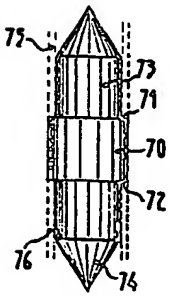
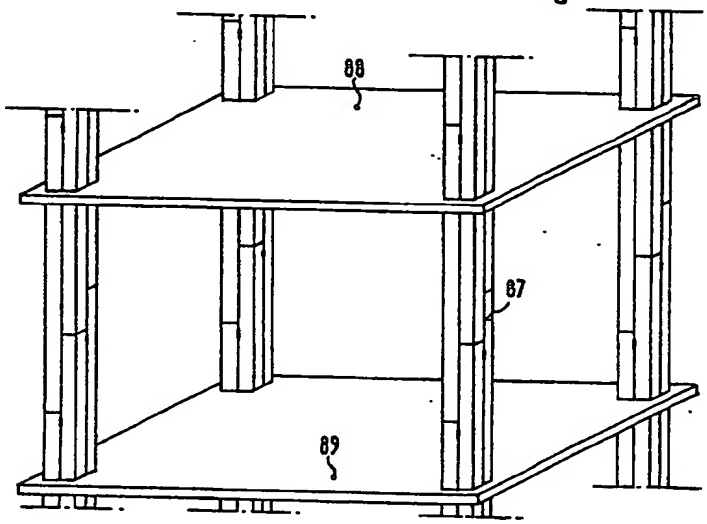


Fig.12

Fig. 16



1033890 COMPLETE SPECIFICATION
7 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheets 6 & 7

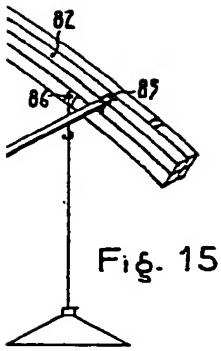


Fig. 15

Fig. 16

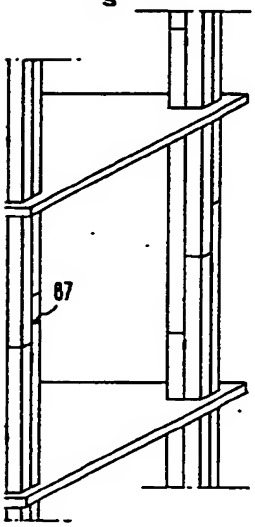
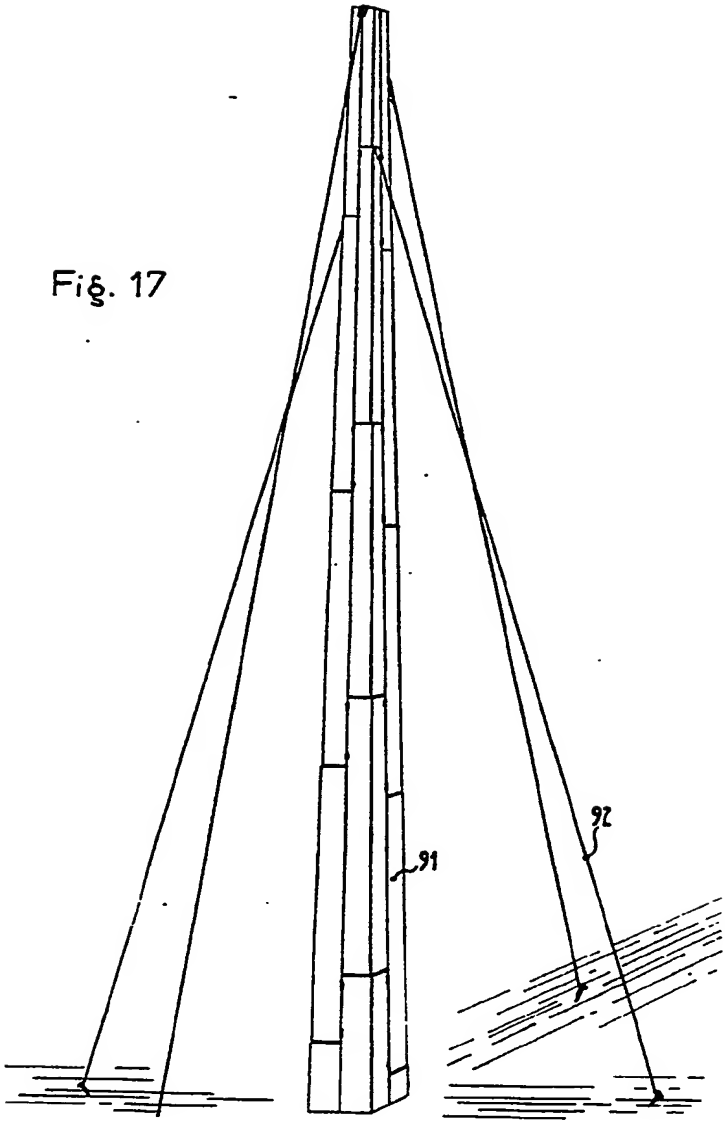


Fig. 17



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Sheets 6 & 7

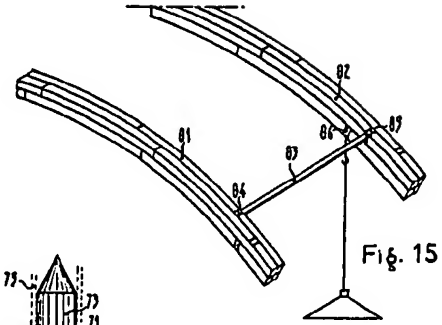

Fig. 15

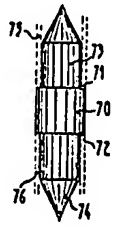

Fig. 12

Fig. 16

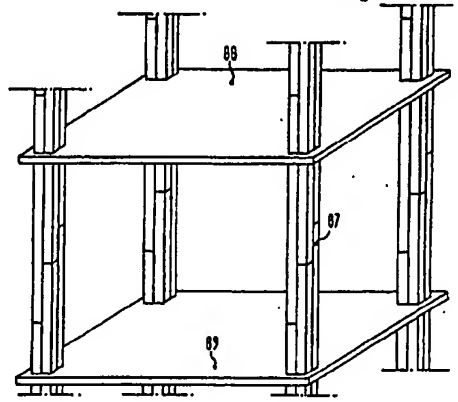

Fig. 17